

COURTSHIP AND MATING IN *HIPPOMELAS PLANICOSTA*
(COLEOPTERA: BUPRESTIDAE)

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ABSTRACT

Mating pairs of *Hippomelas planicosta* remain together for several hours during which time they copulate repeatedly, the male resting on the back of the female in the intervals between copulations. Males stroke their partners with their legs and antennae before, during, and between copulations. Bouts of courtship stroking occur more frequently during copulation than in the resting periods. Stroking may serve to elevate the sexual motivation of the female, eliciting copulation and preventing her premature departure. Intermittent copulation may permit the male to leave the female more quickly if threatened by a predator during a resting period, yet still allow the male to guard the female against takeover by other males.

INTRODUCTION

There are few records of the reproductive behavior of buprestid beetles. Females of *Xenorhipis brendeli* LeC. release a sex pheromone that attracts males (Wellso 1966); males and females of *Polycesta abdita* Barr signal their location by thumping their abdomens on woody substrate (Beer 1970); and in several species of *Agrilus* the male is above the female and oriented in the same direction during a copulation of short duration (Carlson & Knight 1969; Dutt 1969). Here I describe the courtship and copulatory behavior of a large desert buprestid, *Hippomelas planicosta* (LeConte), which I observed from 15-22 July 1975 in the Semi-Regional Park of Avondale, AZ. Much of the park consists of an open sandy floodplain laid down by the nearby Gila River, with scattered creosote bushes, *Larrea divaricata* Cav., a plant whose leaves and stems are eaten by the adult buprestids.

RESULTS

The beetles are active reproductively throughout the daylight hours, with copulating pairs present from 0700-1700, but the period from 0800-1100 appears to be the peak time for mating. Males of *H. planicosta* fly about creosote bushes and sometimes alight on the back of a conspecific individual or a mating pair. Since the perched individuals are immobile and generally well-concealed, olfactory cues may play a role in the location of conspecifics. Males that land upon a mating pair quickly attempt copulation with the beetle immediately beneath them (the male) and then depart. Males that secure a single individual will also initially attempt copulation (unsuccessfully in my observations) and then may engage in courtship stroking (see below) for a moment or for as much as 10 minutes before leaving without copulating.

Successful courtship and mating in *H. planicosta* consists of 2 alternating components: a passive phase in which the male rests above the female and a copulatory phase (Figs. 1, 2). Males that induce a female to copulate then alternate passive and copulatory phases for a prolonged period (more than 2½ hr in 2 pairs that were watched for this length of time).

In the passive phase the male grasps the female and rests on her back without attempting copulation. The tibiae of the male's forelegs press lightly against the edges of her elytra and adjacent anterior abdomen. The hindlegs are wrapped loosely about her posterior abdomen. The midlegs play no role in gripping the female but instead are held out away from her body.

At intervals during the passive phase, the male will engage in a short bout of courtship stroking. The midlegs draw in to the side of the female and then energetically rub against her elytra and abdominal venter. These legs move very rapidly back and forth along approximately ½ the total length of the elytra for 2-5 seconds, and then return to the resting position. In a stroking bout, the tarsi of the male's hindlegs, moving in conjunction with the midlegs, pat the posterior venter of the female's abdomen. In addition, the forelegs may move jerkily about the side of the female's thorax, although this action is far less pronounced than the movements of the other 2 pairs of legs. Finally, the male's antennae drum against the dorsum of the female's thorax or head, or lash the female's antennae, depending on the relative size of the 2 partners (when the male is much smaller than his mate, his antennae cannot reach the head region of the female.)

In the passive phase, stroking often is triggered by movement of the female which normally is sedentary when paired (although she may feed on the stems and leaves on which she rests). Eighty-three of 200 stroking bouts by 8 males took place during the relatively rare moments when the female was walking forward. Another 38% occurred apparently spontaneously as the pair rested motionless on a creosote limb or twig. The final 20% were associated with penile extrusion by the male just prior to an attempted copulation.

As a stroking bout terminates, the male may return to resting passively or may extrude his aedeagus and attempt copulation. Initially this organ points backwards and must be bent downward and then forward into the female's genital opening. Receptive females permit insertion of the aedeagus; copulation lasts about 90 seconds on average but is highly variable in duration. Following withdrawal of the aedeagus, the pair will wait an average of about 3 minutes before the next copulation. Again the length of the passive phase is highly variable (Table 1).

During copulation males engage in significantly more stroking bouts per minute than during the passive intercopulatory phase (Table 1). The performance of the stroking movements, however, is identical to that described above.

DISCUSSION

Two questions on the reproductive behavior of *H. planicosta* need further examination. First, what is the significance of stroking by males? Second, why is copulation intermittent instead of continuous in this species?

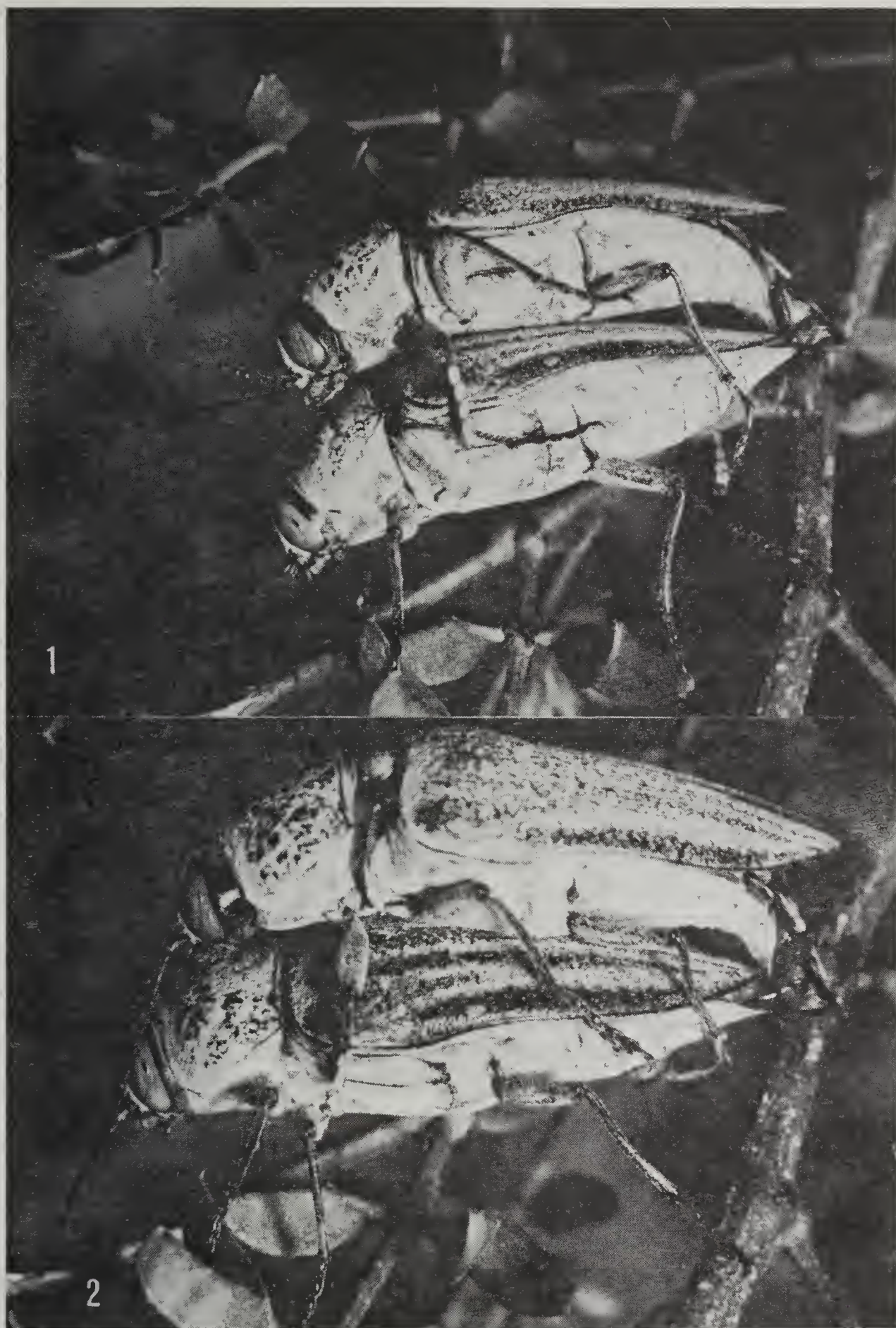


Fig. 1-2. Copulating pairs of *Hippomelas planicosta*. (1) The male (above the female) has inserted his aedeagus but is not stroking his partner. Note that his midlegs are drawn up and away from the female. The male's forelegs happen to grip the female's midlegs in this case, but more normally all the female's legs are free. (2) Stroking by the male. Note the position of the midlegs and antennae of the male. The yellow scales on the lateral edge of the female's elytra have been removed where the male rubbed the female with his midlegs.

Table 1. Duration and frequency of the components of courtship in *H. planicosta*.

	Mean	Range
Duration of observation per mating pair ¹	17.4 min	(8.9-36.4 min)
Percentage of time pair spent <u>in copulo</u>	35.5%	(23-49%)
Number of stroking bouts per minute		
- in the copulatory phase	6.5 bouts ²	(3.0-9.5)
- in the passive phase	2.5 bouts	(0.7-6.6)
Duration of single copulations	89 sec	(29-180 sec)
Duration of interval between successive copulations	172 sec	(14-655 sec)

¹Data are derived from observations of 10 mating pairs; each pair completed 4 consecutive bouts of copulation and 4 resting periods between copulations.

²Stroking occurs significantly more often during copulation.

$$t = 4.47, \text{ d.f.} = 1, p < 0.01$$

The generation of tactile signals by the legs and antennae is common among male beetles, including carabids (Erwin 1967), cerambycids (Michelsen 1966), cucujids (Wojcik 1969), curculionids (Hagley 1965), lyctids (Wright 1960), meloids (Selander & Pinto 1967), rhipiphorids (Linsley *et al.* 1952), tenebrionids (Wojcik 1969), and doubtless other families as well. Most often this involves rubbing the legs against the sides of the elytra and abdomen of the female and antennation of the female's antennae. Some authors have recognized that a passive state on the part of the female is a necessary condition for copulation and that tactile signals by the male appear in several cases to induce immobility and receptivity in the female (Selander 1964; Michelsen 1966; Wojcik 1969).

In *H. planicosta* the tactile signals provided by the male presumably communicate that he is a conspecific to a female. This may promote cooperation from her by elevating her sexual motivation at moments when this is especially critical to the male. Males employ stroking bouts (1) immediately before almost every attempted copulation, (2) more frequently during copulation than during the passive phase, and (3) often when the female is moving during the passive phase. (1) Males must elicit cooperation if the female is to permit entry of the aedeagus. (2) During copulation, stroking may maintain sexual motivation and prevent premature termination of the copulatory bout. (3) A female that is moving is presumably more likely to escape from the male than one that is still. I saw unreceptive females terminate courtship by walking rapidly along a limb until their would-be mate was brushed from their back. They would then fly away. Stroking by the male when the female moves may be part of the male strategy to prevent movement and departure of mating partners. Wojcik (1969) made similar observations on several species of stored-

product beetles; however, Selander & Pinto (1967) found that in the meloid *Linsleya convexa* leg rubbing was *less* frequent when the females were active than when they were passive and immobile.

Stroking, then, may increase the duration of the partnership and elicit cooperation in recurring copulations. Throughout this time the male is on the back of the female and can prevent her from mating with another male. Guarding the female may be an important element of male behavior, although it is not known if a recently mated female will accept another suitor or if sperm competition (Parker 1970) occurs in multiple-mated females. In any case, males do remain with females for several hours but do not copulate continuously during this time. Similar patterns have been reported for a lyctid (Wright 1960) and a weevil (Hadley 1965). What advantage might a male gain from repeated intermittent copulations with the same female over a period of (x), as opposed to *either* (1) an uninterrupted copulation of duration (y) followed by a period of guarding of duration (x-y) *or* (2) a single continuous copulation of duration (x)?

Perhaps alternative (1) has not evolved because through repeated copulations the male may induce the female to remain with him longer than if he were to copulate continuously for some time and then simply rest on her back. In the time following the continuous copulation, the male would have nothing to offer the female and would actually interfere with the performance of other activities (feeding, oviposition) important to the female. It seems likely that with each intromission the female receives additional sperm and accessory fluids that may be of use to her, either increasing her sperm supply or the supply of protein rich materials that she may later metabolize. If so, it may be to her advantage not to break away from the male until many separate copulations have occurred.

Option (2) may be disadvantageous due to predation pressure. The buprestid is sensitive to the presence of observers. Pairs resting between copulations can and do break apart quickly on the approach of a human, with each member flying rapidly away. This suggests that they have been subject to selection for vigilant behavior and the avoidance of potential enemies, which may include large insectivorous birds. Another possible predator is the sphecid wasp *Cerceris grandis* Banks. This large *Cerceris* belongs to a subgroup within the genus whose members are characterized by a set of morphological traits and the use of Buprestidae as prey, although there were no prey records for *C. grandis* when Scullen (1965) included it in the group. I failed to observe the wasp taking the buprestid. However, I regularly saw *C. grandis* females circling around creosote bushes as if hunting; once a wasp pursued a flying *H. planicosta* and once a female actually alighted on a copulating pair, although it left without attempting to capture either individual. If the wasp were a significant predator, it could be that it and other enemies unknown to me are selective agents favoring intermittent bouts of copulation. During passive intervals the pair probably can separate from each other more readily if threatened than when *in copula*.

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